Princeton/Stanford Working Papers in Classics

The size of the economy and the distribution of income in the Roman Empire

Version 2.0

January 2009

Walter Scheidel and Steven J. Friesen

Stanford University and University of Texas

Abstract: Different ways of estimating the Gross Domestic Product of the Roman Empire in the second century CE produce convergent results that point to total output and consumption equivalent to 50 million tons of wheat or close to 20 billion sesterces per year. It is estimated that elites (around 1.5 per cent of the imperial population) controlled approximately one-fifth of total income while middling households (perhaps 10 percent of the population) consumed another fifth. These findings shed new light on the scale of economic inequality and the distribution of demand in the Roman world.

I OBJECTIVE

As Roman economic historians have moved beyond concepts such as formalism and substantivism that exercised previous generations of scholars, questions of economic growth and performance have increasingly come to the fore.[1] Consideration of these issues requires a basic understanding of the probable size of the Roman economy and the distribution of income across its population. This perspective not only encourages us to ask how different segments of the economy – such as the share of output captured by the state or the relative weight of elite wealth – were interrelated and to ponder the overall degree and structure of inequality but also invites and facilitates comparison with other premodern economies. Engagement with such macro-level questions has a short academic pedigree in our field. With the notable exception of the historian-sociologist Keith Hopkins, Roman historians have shied away from addressing the problem of the size of the economy of the empire and effectively ceded this important area of inquiry to a handful of enterprising economists who were not afraid to venture into unfamiliar territory.[2] While scholarly interest in inequality has been less rare among students of the Roman world it has seldom spurred attempts at quantitative analysis, and even economists have only very recently begun to extend their analyses of wealth and income distributions into the distant past.[3] Existing

We are grateful to Peter Bang, Saskia Hin, Branko Milanovic, Richard Saller, Peter Temin, and Greg Woolf for helpful comments on an earlier draft of this paper.

[1] See I. Morris, R. Saller and W. Scheidel, 'Introduction', in W. Scheidel, I. Morris and R. Saller (eds), *The Cambridge Economic History of the Greco-Roman World* (2007), 1-12, and more generally the contributions in the same volume, as well as P. Millett, 'Productive to some purpose? The problem of ancient economic growth', in D. J. Mattingly and J. Salmon (eds), *Economies Beyond Agriculture in the Classical World* (2001), 17-48; R. Saller, 'Framing the debate over growth in the ancient economy', in W. Scheidel and S. von Reden (eds), *The Ancient Economy* (2002), 251-69 and in J. G. Manning and I. Morris (eds), *The Ancient Economy* (2005), 223-38; F. de Callataÿ, 'The Graeco-Roman economy in the super-long run: lead, copper, and shipwrecks', *JRA* 18 (2005), 361-72; R. B. Hitchner, '"The advantages of wealth and luxury": the case for economic growth in the Roman empire', in Manning and Morris (eds) (n.1), 207-22; W. Jongman, 'The rise and fall of the Roman economy: population, rents and entitlement', in P. F. Bang, M. Ikeguchi, and H. G. Ziche (eds), *Ancient Economies, Modern Methodologies* (2006), 237-54; 'The early Roman Empire: consumption', in Scheidel, Morris and Saller (eds) (n.1), 592-618; 'Gibbon was right: the decline and fall of the Roman economy', in O. Hekster, G. de Kleijn and D. Slootjes (eds), *Crises and the Roman Empire* (2007), 183-99; P. F. Bang, 'Trade and empire: in search of organizing concepts for the Roman economy', *P&P* 195 (2007), 3-54; W. Scheidel, 'A model of real income growth in Roman Italy', *Historia* 56 (2007), 322-46; 'In search of Roman economic growth', *JRA* forthcoming; M. Silver, 'Roman economic growth and living standards: perceptions versus evidence', *AncSoc* 37 (2007), 191-252. For economic growth in ancient Greece, cf. I. Morris, 'Economic growth in ancient Greece', *Journal of Institutional and Theoretical Economics* 160 (2004), 709-42; 'Archaeology, standards of living, and Greek economic history', in Manning and Morris (eds) (n.1), 91-126.

[2] K. Hopkins, 'Taxes and trade in the Roman empire (200 B.C. – A.D. 400)', *JRS* 70 (1980), 101-25; 'Rome, taxes, rents, and trade', *Kodai* 6/7 (1995/6), 41-75, reprinted in Scheidel and von Reden (eds) (n.1), 190-230; 'The political economy of the Roman empire', in I. Morris and W. Scheidel (eds), *The Dynamics of Ancient Empires* (2009), 178-204. Among economists, R. W. Goldsmith 'An estimate of the size and structure of the national product of the early Roman empire', *Review of Income and Wealth* 30 (1984), 263-88 was a pioneering study, with considerable delay followed by P. Temin, 'Estimating GDP in the early Roman Empire', in E. Lo Cascio (ed), *Innovazione tecnica e progresso economico nel mondo romano* (2006), 31-54; A. Maddison, *Contours of the World Economy, 1-2030 AD* (2007), 11-68; B. Milanovic, P. H. Lindert and J. G. Williamson 'Measuring ancient inequality', NBER Working Paper 13550 (October 2007), 64-9.

[3] See now esp. B. Milanovic, 'An estimate of average income and inequality in Byzantium around year 1000', *Review of Income and Wealth* 52 (2006), 449-70; Milanovic, Lindert and Williamson (n.2); and also R. C. Allen, 'How prosperous were the Romans? Evidence from Diocletian's Price Edict (301 AD)', University of Oxford, Department of Economics, Discussion Paper Series No. 363 (October 2007),

contributions by economists are tremendously helpful in sketching out different ways of tackling big questions about economic performance with notoriously meager data but pose their own problems in so far as they rest on a superficial appreciation of the complexities of the evidence and inadequate knowledge of Roman history in general. Moreover, the simple fact that these attempts have resulted in strikingly divergent estimates of Roman economic output certainly counsels caution. We want to show that there is much to be gained from revisiting these problems by combining an awareness of the breadth and pitfalls of the ancient evidence with models drawn from economics.

We have two main objectives. The first is to establish, through a variety of methods, a convergent range of estimates of the size of the economy (that is, the Gross Domestic Product) of the Roman Empire at the time of its putative demographic peak in the mid-second century CE. The second is to ask who enjoyed the fruits of that economy by developing a model of income distribution and inequality, informed by our estimate of overall GDP. The answer to this question is vital for all Roman social history. Were there just a few super-wealthy surrounded by a mass of relatively undifferentiated poor? Or were there middling groups and a more finely gradated continuum from wealth to indigence?[4]

In methodological terms, we seek to emphasize the interconnectedness of wages, prices, elite wealth, and per capita GDP. It is true of all societies that these variables do not operate independently of each other: our estimates for one necessarily limit the possible values the others may have. This helps narrow down the range of plausible reconstructions historians may make. More specifically, we advocate the application of a schematic income scale in order to clarify the logical implications of different GDP estimates for our understanding of inequality and group-specific living standards. Put otherwise, any estimate of the total size of the Roman economy will have consequences for how wealth was distributed, and the conditions in which individuals actually lived their lives.

We argue that the population of the Roman Empire generated a total income approaching the equivalent of 50 million tons of wheat or close to 20 billion sesterces per year; that the state and local government captured a small share of overall income, of not much more than 5 percent; that the top 1.5 percent of households controlled around one-fifth of total income; that economically 'middling' non-elite groups accounted for a modest share of the population (around 10 percent) but perhaps another fifth of total income; and that the vast majority of the population lived close to subsistence but cumulatively generated more than half of overall output. These findings support a conservative reading of Roman economic history but serve to qualify both dichotomous visions of a Roman society divided into elites and subsistence workers on the one

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forthcoming in A. Bowman and A. Wilson (eds), *Quantifying the Roman Economy* (2009). Among ancient historians, A. K. Bowman, 'Landholding in the Hermopolite nome in the fourth century AD', *JRS* 75 (1985), 137-63 and R. S. Bagnall, 'Landholding in late Roman Egypt: the distribution of wealth', *JRS* 82 (1992), 128-49 stand out for their use of the rich material from late Roman Egypt. On Roman inequality more generally, see most recently S. Friesen, 'Poverty in Pauline Studies: beyond the so-called New Consensus', *Journal for the Study of the New Testament* 26 (2004), 323-61 and W. Scheidel, 'Stratification, deprivation and quality of life', in M. Atkins and R. Osborne (eds), *Poverty in the Roman World* (2006), 40-59. For Greece cf. L. Foxhall, 'Access to resources in classical Greece: the egalitarianism of the polis in practice', in P. Cartledge, E. E. Cohen and L. Foxhall (eds), *Money, Labour and Land* (2002), 209-20, with earlier literature.

[4] For critiques of dichotomous assessments, see Friesen (n.3), esp. 339-40 with reference to J. J. Meggitt, *Paul, Poverty and Survival* (1998), 1-7, as well as Scheidel (n.3), esp. 43-44 with reference to P. A. Brunt, *Italian Manpower 225 B.C. – A.D. 14* (1987), 383; P. Garnsey and R. Saller, *The Roman Empire* (1987), 116; H. Kloft, *Die Wirtschaft der griechisch-römischen Welt* (1992), 203; W. Jongman, 'Hunger and power: theories, models and methods in Roman economic history', in H. Bongenaar, (ed), *Interdependency of Institutions and Private Entrepreneurs* (2000), 271; J. Toner, *Rethinking Roman History* (2002), 50-1. See also P. Veyne, 'La "plèbe moyenne" sous le Haut-Empire romain', *Annales* 55 (2000), 1169-99.

hand and overly optimistic assessments of income growth and the role of 'middling' elements on the other. They also make it feasible, for the first time, to quantify different segments of consumer demand.

A word of caution. Students of the Roman world who are unfamiliar with our approach might be tempted to dismiss this project as a tangled web of conjecture. We would agree with this definition but urge our audience to focus on the web's texture. Our reconstruction is in its entirety a matter of controlled conjecture: undeniably conjecture, given the paucity of 'hard' data, yet tightly controlled by the interdependence of different assumptions and the constraints imposed by comparative evidence. Historically-minded economists have long been accepting of controlled conjecture because of its potential to illuminate features of the past that are worth apprehending, however roughly, and we believe that is important for ancient historians to recognize both the promise and the limits of this approach. At the very least, we hope to demonstrate that individual assumptions about the Roman economy need to be tested against a whole range of intersecting variables. Future attempts to revise any of our propositions will have to take proper account of this basic requirement.

II HOW BIG WAS THE ROMAN ECONOMY?

Method

The size of the economy of the Roman Empire cannot be measured but may be estimated in a number of ways.[5] One is from the expenditure or consumption side, by estimating how much would have been consumed and valuing these amounts in cash or real terms, preferably by expressing them in grain equivalent. Another way is from the income side, by estimating group-specific earnings, once again in cash or real terms. A third method that to the best of our knowledge has never been employed before is to predict historically plausible GDP totals from the relationships between significant indicators, such as the ratio of unskilled rural worker's wages to mean per capita GDP and the ratio of per capita subsistence to mean per capita GDP, both of which have recently been estimated for a number of historical economies. This procedure rests on a simple equation with three variables: when wages and subsistence costs (i.e., the first variable) are known and comparative data suggest a plausible range of ratios (i.e., the second variable), we are able to extrapolate the third variable – mean per capita GDP – from this information. We pursue these three approaches in turn, critiquing existing attempts and offering support for our own estimates. Our findings suggest upper and lower limits as well as plausible core estimates for Roman GDP that enable us to narrow the range of options to a very significant degree.

This multi-pronged approach serves to reduce the risk of *a priori* or circular reasoning in as much as each method yields results that are predicated on a separate and different set of starting assumptions. Rather than relying on a given set of premises that predetermines the final outcome (such as, for example, the amount of surplus beyond subsistence generated by the Roman economy), we introduce scenarios that are likely to underestimate or overestimate actual GDP in addition to estimates designed to ascertain the latter. Thus, in the case of consumption-

[5] In dealing with the Roman Empire as a whole, it is legitimate to elide the differences between Gross Domestic Product (i.e., expenditure, value added in production, and income generated within a given unit of observation), Gross National Product (GDP plus or minus net receipts from transfers of property or labor income from outside a given unit of observation), and National Disposable Income (GNP plus or minus net current transfers received in money or kind from outside the unit of observation): see Maddison (n.2), 45. However, these differences do matter in more narrowly focused regional studies, especially in the case of Roman Italy as a net recipient of transfers from its provinces: see below, n.50.

based estimates, and to a lesser extent for income-based estimates, we are compelled to make starting assumptions about base-level living standards that inevitably bias our results. We address this problem by employing both pessimistic and optimistic starting assumptions which generate results that we interpret as bounding estimates of actual GDP rather than as approximations of reality. Comparative evidence, represented by income-ratio-based calculations, plays an important role in moving from minima and maxima to plausible estimates of GDP. Cross-cultural analogy moderates the degree of circularity inherent in our web of conjectures: instead of predicting a specific low or high aggregate income on *a priori* grounds, we merely assume that in terms of average per capita performance the Roman economy did not dramatically differ from most other preindustrial systems and fell short of the achievements of the most advanced economies of the early modern world, those of the Netherlands and England.

It is worth emphasizing that the latter assumption does not shape our estimates of Roman economic performance in an unduly arbitrary or circular way. Even the most fleeting appraisal of the Dutch economy in the early modern period shows that it is both legitimate and desirable to employ historical comparison for the purpose of establishing an absolute ceiling that the Roman Empire, as a whole, would necessarily have been unable to approach, let alone breach. Labeled the 'first modern economy', the 'Golden Age' Netherlands enjoyed unusually large energy inputs, provided by fossil fuels in the form of local peat deposits, that were unavailable to other 'organic', preindustrial economies; attained levels of formal schooling and literacy that were exceptional by pre-modern standards; created a flourishing bond market; and was the first country on record in which the share of the population engaged in farming fell below one-half.[6] None of these and many related manifestations of progress are attested for or can reasonably be attributed to the Roman Empire.

Dutch per capita GDP in 1600 has recently been estimated at $1,381 expressed in so-called Geary-Khamis dollars (a hypothetical unit of currency that had the same purchasing power as 1 US dollar did in 1990).[7] Yet at that time a mere 2 million people lived in the Netherlands: It was not until the early nineteenth century (probably around 1820) that the combined populations of the eight richest countries on earth reached a size that equaled that of the Roman Empire and enjoyed an average per capita income that matched the one the Netherlands had first attained by 1600.[8] This means that unless we are prepared to believe that average per capita income *throughout the Roman Empire* was as high as the mean for Austria, Belgium, Denmark, France, the Netherlands, Sweden, the United Kingdom and the United States in the early nineteenth century, Dutch economic performance around 1580/1600 – or that of England roughly a century later – does in fact represent a level of development that the Roman world as a whole could not possibly have hoped to reach.[9] This example shows that comparative evidence does indeed provide solid constraints on our conjectures regarding conditions in antiquity.

[6] See J. de Vries and A. van der Woude, *The First Modern Economy* (1997), esp. 693-710 for a succinct summary.

[7] Maddison (n.2), 382. The corresponding for value for the United Kingdom in 1700 is $1,250.

[8] Ibid. (for a mean of $1,350 for a population of some 75 million in the countries listed in the text below).

[9] This does in no way preclude the possibility of relatively high income levels in pockets of development such as Roman Italy or the Aegean.

GDP Estimates Based on Expenditure[10]

Existing estimates on the consumption side date back to 1980 when Keith Hopkins estimated total consumption in the Roman Empire in terms of wheat equivalent in order to provide what he defined as a "*minimum* estimate" but observed that "in reality, the gross product of the Roman empire must have exceeded our estimated minimum gross product considerably".[11] His proposed minimum of HS8.2bn was the result of a simple multiplication of putative minimum annual subsistence consumption of 250kg of wheat equivalent per capita plus one-third to allow for seed or equivalent inputs with a notional mean wheat price of HS0.458 per kg of wheat and a putative imperial population of 54 million in 14 CE.[12] He also suggested that actual GDP "averaged out at less than twice minimum subsistence" whereas in a later restatement of his model he speculated that GDP was "perhaps between a third and a half higher" than the minimum and favored a "rough guess" of 50 percent above minimum GDP, for a total of HS13.5bn for a revised population tally of 60 million (see Table 1).[13]

There are four problems with this approach. First of all, comparative evidence suggests that annual consumption of 250kg of wheat equivalent may be insufficient to ensure long-term survival.[14] Secondly, the underlying wheat price of HS3 per *modius* (8.62 liter or 6.55kg of wheat) is necessarily just a guess and may not be applicable to the empire as a whole, an important issue to which we return below. Thirdly, seed, which accounts for one-quarter of proposed minimal consumption, is not normally included in calculations of GDP,[15] which means that Hopkins was effectively advocating a lower mean per capita product of 375kg of wheat equivalent and a total of HS9.3-10.1bn for an empire of 54-60 million people. And at least as importantly, his chosen step-up for actual relative to minimum consumption is arbitrary and not grounded in ancient or comparative evidence.

Since 1984, several economists have devised more detailed consumption-based estimates that seek to quantify intake beyond wheat consumption at subsistence levels (Table 1). In the most influential study to date, Raymond Goldsmith started with a base intake of actual wheat of *c.*250kg that was the same as Hopkins's subsistence consumption in wheat *equivalent* and thus much larger in real terms.[16] With wheat once again priced at HS3 per *modius* (for annual mean expenditure of HS112 per person), Goldsmith allowed for a moderate increase to HS130 in order to account for other food grains and put total food expenditure at HS200, an 80 percent increase over expenditure on wheat alone.[17] He then applied a step-up of 75 percent to account for total private non-food expenditure, a proportion he derived from various strands of comparative evidence, and added HS30 for government expenditures (estimated at 5 percent of GDP) and

[10] This and the following two sub-sections contain a fair amount of technical detail and tentative quantification that are necessary to justify our estimates. We believe that it is imperative to engage with earlier scholarship and explain our choices but encourage readers who do not wish to follow each step in our reasoning to concentrate on the results in the final sub-section below, on pp.15-16.

[11] Hopkins 1980 (n.2), 117-20 (quotes at 118-19; italics in original).

[12] Hopkins 1980 (n.2), 119; and cf. 1995/6 (n.2), 45-6 = 2002 (n.2), 198-9 for the same calculation based on a population of 60m, for a minimum total of HS9bn.

[13] Hopkins 1980 (n.2), 120 (less than twice subsistence); 1995/6 (n.2), 47 = 2002 (n.2), 201 (one-third to one-half higher).

[14] E.g., C. Clark and M. Haswell, *The Economics of Subsistence Agriculture* (4th ed 1970), 59-64.

[15] Thus Goldsmith (n.2), 273 n.51; Temin (n.2), 36.

[16] Goldsmith (n.2), 266, reckoning with mean wheat consumption of 35-40 *modii* (which he set at 6.75kg) per average person, a figure that is surely too high: see, e.g., L. Foxhall and H. A. Forbes, '*Sitometreia*: the role of grain as a staple food in classical antiquity', *Chiron* 12 (1982), 41-90; P. Garnsey, *Famine and Food Supply in the Graeco-Roman World* (1988), 104; *Cities, Peasants, and Food in Classical Antinquity* (1998), 193, 203; cf. *Food and Society in Classical Antiquity* (1999), 19-20.

[17] Goldsmith (n.2), 267, referring to a 60 percent share of food costs in 1950s India.

gross capital expenditures, thereby arriving at a total per capita GDP of HS380, or about HS21bn for a population of 55 million in 14 CE.[18]

This schedule has come to serve as a template for other economists who have attempted to fine-tune his reconstruction by altering various input values whilst preserving the overall structure of his derivation. Thus, in 2007 Angus Maddison accepted most of Goldsmith's assumptions with only minimal adjustments, most notably a somewhat higher share of state expenditure and investment that marginally improved on the original breakdown. Reckoning with a significantly smaller population of 44 million in 14 CE, he retained the proposed per capita mean of HS380 but obtained a lower total GDP of HS16.7bn.[19] A year earlier, Peter Temin had advocated more radical revisions of Goldsmith's tabulation by adopting the much lower wheat price from Roman Egypt of 8 drachmas per *artaba* (*c.*29.5 kg) of wheat, equivalent to HS1.78 per *modius*, and a much more realistic level of actual wheat consumption. Thanks to the process of multiplication from mean per capita wheat consumption expressed in cash that lies at the root of the entire schedule, these reductions necessarily greatly shrank the final tallies, cutting mean per capita GDP by more than half to HS166 and lowering total GDP to HS9.15bn for a population of 55 million.[20]

Table 1 Estimates of GDP from the expenditure side

	Hopkins	Goldsmith	Temin	Maddison
Wheat price per kg	HS 0.458	HS 0.444	HS 0.271	HS 0.441
Mean annual wheat (equivalent) consumption	250 kg	253 kg	175 kg	253 kg
Allowance for seed	83.3 kg	-	-	-
Value of mean annual wheat (equivalent) production	HS 153	HS 112	HS 48	HS 112
Mean annual food expenditure	-	HS 200	HS 86.4	HS 200
Mean annual private expenditure	-	HS 350	HS 151.2	HS 330
Mean annual public and investment expenditure	-	HS 30	HS 15.12	HS 50
Mean annual total expenditure	HS 153	HS 380	HS 166.3	HS 380
Population	54m*-60m**	55m	55m	44m
Minimal aggregate expenditure	HS 8.244bn* HS 9bn**			
Actual aggregate expenditure	<HS 16.5bn* HS (12-)13.5bn**	HS 20.9bn	HS 9.15bn	HS 16.72bn
Mean total expenditure (cash)	HS 225	HS 380	HS 166	HS 380
Mean total expenditure (wheat)	491 kg	843 kg	614 kg	843 kg

* Hopkins 1980 (n.2), 119-20
** Hopkins 1995/6 (n.2), 47 = 2002 (n.2), 201

[18] Goldsmith (n.2), 268, 273 table 1.
[19] Maddison (n.2), 45-7, reckoning with HS1.1bn government spending and investment equivalent to 6.5 percent of GDP analogous to 1688 England; and see 32-36 for population size.
[20] Temin (n.2), 47.

Table 1 reveals that these four estimates of mean per capita GDP vary by 129 percent in cash terms (from HS166 to 380) and by 72 percent in real (i.e., wheat) terms (from 491 to 843kg). Whilst this wide range alone inspires little confidence in any one of these figures, what matters most is that each of the underlying estimates is flawed in several ways. The problem that is easiest to address is the tendency to underestimate overall population size. The year 14 CE, the common point of reference, is of no particular relevance for economic or demographic purposes and by no means better known than any other year of the imperial period. In order to establish standardized GDP estimates, we prefer to focus on the period of putative maximum population size in the mid-second century CE (prior to the 'Antonine Plague'), which may well have reached 70 million.[21] However, divergent estimates of population number do not affect per capita GDP.

Our ability to approximate the latter is severely limited by our inability to establish a genuinely average price of wheat for the entire Roman Empire. The notional wheat price of HS3 per *modius* favored by Hopkins, Goldsmith, and Maddison owes its existence to Tacitus' observation that after the great fire in Rome in 64 CE, the emperor Nero reduced the metropolitan wheat price to that amount in order to prevent shortages (*Ann.* 15.39). Yet not only is it impossible to tell how this rate was meant to relate to 'normal' prices in the capital, it does not tell us anything at all about the cost of grain elsewhere. Excluding instances of shortages, other reported grain prices include HS2, 2.5, 3, and 3.5 per *modius* in Sicily in the 70s BCE, HS3 and, perhaps, 7.5 in first-century CE Pompeii, HS4 in Forum Sempronii, HS2, 2.25, and 4 in Pisidian Antioch in the 90s CE, and the equivalent of HS4-8 in Rabbinic texts from the first to third centuries CE.[22] Reported flour prices imply higher wheat prices of HS6-8, most likely for the city of Rome proper.[23] In any case, the only existing documentary price series comes from Roman Egypt and attests to a 'typical' wheat price of 8 or 9 drachms per *artaba* (i.e., HS1¾ to HS2 per *modius*) in the period from the mid-first to the mid-second centuries CE.[24]

The only thing we can be sure of is that actual prices varied quite significantly by region, being lowest in grain-exporting Egypt and highest in the capital. More specifically, observed variation suggests that while the conventional valuation of HS3 per *modius* need not be wide of the mark it is nevertheless unduly precise, whereas Temin's application to the entire empire of the unusually low wheat prices that were characteristic of Egypt necessarily understates nominal (cash) GDP. Conversely, the high level of per capita wheat consumption on which Goldsmith and Maddison's simulations are based skews their final tallies too far upwards. In sum, whereas Temin's estimate is bound to be too low, theirs may well be too high.

It is true that cash valuations cannot be wholly avoided in estimates of Roman GDP and are therefore bound to widen the margin of error. For this reason, we ought to use a range instead of a single number to accommodate uncertainty and demarcate the limits of the plausible. Most importantly, this problem speaks against the common method of assigning a – putatively representative but necessarily arbitrary – cash value to wheat right at the beginning of a given

[21] See W. Scheidel, 'Demography', in Scheidel, Morris and Saller (eds) (n.1), 48 table 3.1 for a conjectural breakdown by region, revising B. W. Frier, 'The demography of the Early Roman Empire', in *CAH* XI (2nd ed 2000), 814 table 6 (*c.*61m in 164 CE). If anything, our tally of 70 million may still be too low, given the probable size of Italy's population alone, for which see now W. Scheidel, 'Roman population size: the logic of the debate', in L. de Ligt and S. Northwood (eds), *People, Land and Politics* (2008), 15-70 in response to even higher but less plausible estimates.

[22] See most recently D. W. Rathbone, 'Living standards and the economy of the Roman empire (I-III AD)', in Bowman and Wilson (eds) (n.3), and also W. Scheidel, 'Real wages in early economies: evidence for living standards from 2000 BCE to 1300 CE', forthcoming.

[23] N. Jasny, 'Wheat prices and milling costs in ancient Rome', *Wheat Studies of the Food Research Institute* 20 (1944), 166; G. Rickman, *The Corn Supply of Ancient Rome* (1980), 240; R. Duncan-Jones, *The Economy of the Roman Empire* (2nd ed 1982), 346.

[24] W. Scheidel, 'A model of demographic and economic change in Roman Egypt after the Antonine plague', *JRA* 15 (2002), 103 (8 drachms); Rathbone (n.22) (9 drachms).

derivation where it is bound to exert disproportionate influence on the final result. Although cash valuations will occasionally have to be assigned at a later stage in the process, they must not be allowed to contaminate the base of an estimate.

A safer alternative is provided by calculations in terms of wheat equivalent that are rooted in comparative evidence for subsistence requirements. This method has the additional advantage that it establishes a quasi-objective standard which facilitates cross-cultural comparison. The first data column in Table 2 represents our attempt to recalculate expenditure in real terms by applying an adjusted version of Goldsmith's template. We use the more realistic wheat consumption estimate of 175kg per capita favored by Temin and Goldsmith's step-ups for non-grain and non-food private consumption. Unfortunately, state consumption cannot be denominated in grain terms because the relevant information is commonly expressed in cash, such as soldiers' stipends and officials' salaries.[25] While it would certainly be possible to weight government expenditure as a range of values (derived from a set of different wheat prices), it should be noted that this item is so small relative to total consumption that in this specific case the difference between HS2 or 3 or 4 per *modius* would have only a trivial impact on the final tally. For this reason, we adopt a *purely notional* mean wheat price of HS0.5 per kg as a computational device in order to express public sector spending of approximately HS1bn in wheat terms.[26] Following Maddison's suggestion, investment is notionally put at 6.5 percent of GDP: once again, this item is of comparatively minor importance. This process yields annual mean per capita consumption of 620kg of wheat equivalent, intermediate to the highest and lowest estimates in Table 1. At a population of 70 million this translates to 43.4m tons. The existing data (discussed above) suggest that HS2-3 per *modius* may have been a reasonable wheat price for provincial areas, at any rate among the rural majority: at this range, a GDP of 43.4m tons translates to between HS13bn and HS20bn.

Table 2 Estimates of GDP in wheat equivalent consumption

	Goldsmith/ Maddison ratios (adjusted)	'Bare bones' level (Egypt)	'Respectability' level (Egypt)
Mean annual wheat consumption	175kg	129kg	(164kg)
Mean annual food expenditure	315kg	220kg	-
Mean annual private expenditure	551.3kg	335kg	852kg
Mean annual public expenditure	28.6kg	(28.6kg)	(28.6kg)
Mean annual investment expenditure	40kg	(25kg)	(60kg)
Mean annual total expenditure	620kg	390kg	940kg
Population	70m	70m	70m
Aggregate expenditure	43.4bn kg	27.3bn kg	65.8bn kg
Cash equivalent @ HS 2/modius	HS 13.2bn	HS 8.3bn	HS 20.1bn
@ HS 2.5/modius	HS 16.6bn	HS 10.4bn	HS 25.1bn
@ HS 3/modius	HS 19.9bn	HS 12.5bn	HS 30.1bn

[25] See R. *Duncan-Jones, Money and Government in the Roman Empire* (1994), 33-9.

[26] This results from Duncan-Jones's ([n.25], 45 table 3.7) estimate of an imperial budget of approximately HS900m budget around 150 CE (cf. also R. Wolters, *Nummi signati* [1999], 223 for HS800m after 84 CE) and allows for HS100m in municipal taxes, a total that may in fact have been higher. For the significant role of municipal taxation, see now esp. H. Schwarz, *Soll oder Haben?* (2001). Since much government spending occurred in Rome and Italy and at the frontiers, where prices may have been above average, our notional wheat price of HS3.3 per *modius* may well be on the low side.

This estimate is meant to approximate aggregate actual consumption at a conservative level that extrapolates from subsistence needs without allowing for factors such as food spoilage and the higher base costs of elite consumption, and may therefore be thought to be on the low side. An alternative method helps us to establish both a firm lower limit as well as a plausible upper limit for mean consumption that can both serve as controls on projected tallies of probable GDP. For this purpose, we adopt the concept of the 'consumption basket' that economic historians of the modern period have long used to estimate and compare real wages and track their change over time. The second data column of Table 2 estimates per capita subsistence in terms of what the economic historian Robert Allen has termed a 'bare bones basket,' which assumes the lowest-cost configuration of goods that ensures base-level calorie intake and the rudimentary provision of clothing, heating, and shelter for an adult man or, if multiplied by three, for a family of four.[27] We rely on the results of Scheidel's recent calculation of the cost of a 'bare bones basket' for Roman Egypt from the mid-first to the mid-second centuries CE that is based on papyrological records and supplemented by comparative evidence.[28] At 390kg of wheat equivalent per capita, this yields a threshold that was undoubtedly exceeded in real life: after all, this estimate assumes that every single person in the Roman Empire was barely scraping by, which evidently cannot have been the case.[29]

For contrast, the third data column in Table 2 repeats this exercise with reference to a 'respectability basket,' that is, a consumption basket that would have been provided a much more adequate (if far from luxurious) existence. At 940kg of wheat equivalent, or 240 percent of the consumption level associated with the 'bare bones basket,' implied per capita GDP exceeds the minimum by a wide margin, and comparative evidence suggests that it is too high to serve as a credible estimate of mean per capita consumption. In all European and Asian economies except England and Holland that were reviewed by Allen and associates, in the period from 1500 to 1800 the average incomes of unskilled workers did not normally reach that level (represented by equivalent respectability baskets adjusted for local differences in foodstuffs), and in some cases its was barely exceeded even by the incomes of higher-earning skilled craftsmen.[30]

It is hazardous though perhaps not entirely impossible to relate mean consumption at the levels of the 'respectability basket' to mean per capita GDP. For example, in France at the beginning of the eighteenth century an average person consuming at the level of a local 'respectability basket' would have had to earn about 64 livres per year in Strasbourg and 92 livres in Paris, at a time when mean national per capita GDP has been estimated at 109 livres.[31] Once we add step-ups for state expenditure (about 5 per cent of GDP) and investment (perhaps another

[27] See Allen (n.3). Adult women and minors consume less than adult men.

[28] Scheidel (n.22), table 2. The equivalent of 300kg would keep an average person alive and barely clothed (cf. Clark and Haswell [n.14], 64). If all food had been consumed in the form of wheat and there had been no other consumption, 210kg per year would have sufficed for long-term survival: cf. R. D. Graham *et al.*, 'Nutritious subsistence food systems', *Advances in Agronomy* 92 (2007), 61 table XV for mean caloric intake in several developing countries.

[29] Allen (n.3) undertook an equivalent calculation utilizing the price data in Diocletian's Price Edict of 301 CE. His findings, however, imply an annual mean of only 204kg of wheat equivalent per average person, which is too low even for bare subsistence covering food, clothing, shelter, and fuel (see n.28, and below); this suggests that the imposed price controls sufficiently deviate from normal prices to preclude realistic estimates. In any case it is preferable to use actual prices such as those from Egypt.

[30] R. C. Allen, 'The great divergence: wages and prices from the Middle Ages to the First World War', *Explorations in Economic History* 38 (2001), 429 figs.7-8; Allen *et al.*, 'Wages, prices, and living standards in China, Japan, and Europe, 1738-1925', GPIH Working Paper No. 1 (October 2005); Allen (n.3), 14 fig.2.

[31] J. A. Goldstone, *Revolution and Rebellion in the Early Modern World* (1991), 204 table 8 (GDP and taxes); Allen (n.30), 428 table 6 (welfare ratio); Allen's data at http://www.iisg.nl/hpw/data.php#europe (wages).

5 percent or more), required earnings rise to at least 70+ and 100+ livres per year, equivalent to roughly between two-thirds and full mean per capita GDP. In as much as France in 1700 was more developed than the Roman Empire, we may therefore suspect that in an ancient economy mean per capita GDP was unlikely to exceed mean annual consumption at the level of a 'respectability basket' plus step-ups by a wide margin, if indeed at all. This in turn indicates that the tallies in column 3 of Table 2 can be understood as a probable ceiling for Roman GDP estimates.

GDP Estimates Based on Income

The principal complement to expenditure-based estimates of GDP is provided by estimates of aggregate income which must match the amount of consumption. The principal components are labor and non-labor income (Table 3). Goldsmith was the first to apply this approach to Roman history, assuming "an average labor income of HS3½" per day that was meant to strike a balance between higher wages of skilled workers and lower wages of women, minors and slaves. Allowing for 225 effective work days per year (a reasonable assumption for pre-industrial economies), albeit "with a rather wide margin of uncertainty," this yields a mean labor income of close to HS800 per worker, or, given an employment rate of 40 percent of the total population (i.e., 1 worker per 1.5 non-workers), translates to a mean annual per capita labor income of HS315. Goldsmith proposed a step-up of 20 percent to account for non-labor income, represented by rents, interest, indirect taxes, and depreciation, that was derived from comparative data for the respective share of non-labor income in the GDP of low-income countries in the 1970s. This conjecture allowed him to reconcile his income-based tally of HS380 with his expenditure-based tally of the same amount.[32] As before, Maddison adopted these calculations with relatively minor adjustments, proposing a lower employment rate of 36 percent and a higher non-labor income (which he defined as elite income) but retaining the same overall tally of HS380.[33]

This approach suffers from the problem that since the mean per capita GDP derived from Goldsmith and Maddison's expenditure-based estimates has been shown to be implausibly high, it is troubling that an income-based approach should yield the same result. In fact, the main reason for this apparent match is that the assumed average daily wage of HS3.5 is essentially arbitrary. Representative base wages are unavailable outside Egypt and attested figures vary as much as the wheat prices discussed in the preceding sub-section. A popular passage, Cicero's *Pro Roscio Comoedo* 28, in an overtly rhetorical context, claims that an unskilled slave could hardly have brought in HS3 per day: apart from the possibility of rhetorical distortion, we cannot tell if this tally was supposed to refer to gross or net income derived from slave hire; if it was the latter, the high cost of living in Rome (even for a slave) means that gross pay may well have been considerably higher. Dacian miners were paid HS28, 47, and 70 per month, the same as miners in Egypt: expressed in terms of 225-250 work days per year, this amounts to anywhere from HS1.3 to HS3.7 per work day. This compares to daily wages of HS4 for Matthew's parable of workers in a vineyard, a town scribe in Spain, a cistern supervisor in North Africa, and (plus bread) for a worker in Pompeii. Daily wages for unspecified work reported in the Rabbinic tradition range from HS3.3 all the way to 32, with HS4 being somewhat common.[34] The range of regions – with different price levels – and occupations involved makes it difficult to distill an average wage from

[32] Goldsmith (n.2), 269, 271, 273.
[33] Maddison (n.2), 47.
[34] See Scheidel (n.1), 335 n.51; H. Cuvigny, 'The amount of wages paid to the quarry-workers at Mons Claudianus', *JRS* 86 (1996), 139-45; D. Sperber, *Roman Palestine 200-400* (2nd ed 1991).

these sources. Moreover, the only known actual wage series, from Roman Egypt, consistently indicates lower wages of HS1 or slightly more per day for unskilled rural workers.[35]

Unlike Goldsmith and Maddison, Temin sought to take account of the Egyptian evidence by creating a notional average wage for workers that lies halfway between the low Egyptian wage (set at HS1) and what he considered to be the daily wage in the city of Rome of HS3-4, opting for an average wage of "one-half the Roman level, somewhat above the low level of Egyptian rural wages," or HS1.75 per day (i.e., one-half of HS3.5).[36] This, however, is problematic not only because there is no evidence for Temin's claim that "[t]he daily wage in Rome itself was about HS 3 to HS 4" but also and more importantly because in his own expenditure-based estimate he used (low) Egyptian wheat prices rather than some intermediate rate. This may explain why his income-based estimate does not match his expenditure-based estimate (see above, Table 1). What is more, Temin neglects to consider the logical implications of this procedure for his estimate of aggregate non-labor income. If per capita non-labor income is halved as well, total elite income would have been less than HS2bn, which cannot be reconciled with what little we know about this topic (see below, Section III). Yet if we retained Goldsmith's estimate for non-labor income, Temin's total would rise to HS12.3bn and the discrepancy from his expenditure-based estimate would grow to one-third.

Table 3 Estimates of GDP from the income side

	Goldsmith	Temin	Maddison
Mean daily wage	HS 3.5	HS 1.75	
Working days per year	HS 225		
Mean annual wage	HS 790		
Labor participation rate	40%		
Mean labor income per capita	HS 315		HS 280
Mean non-labor income per capita	HS 65		HS 100
Total mean income per capita	HS 380		HS 380
Population	55m		44m
Aggregate labor income	HS 17.325bn		HS 12.314bn
Aggregate non-labor income	HS 3.575bn		HS 4.406bn
Aggregate total income	HS 20.9bn	HS 10.45bn*	HS 16.72bn

* Temin (n.2), 46 refers to "about HS 10,000 million". The present tally is derived by halving the starting amount of Goldsmith's calculation.

As before, the best solution is to express incomes in real terms instead of committing to a necessarily specious single cash wage from the outset. Wheat equivalent wages for Roman unskilled workers can be computed from three sources, namely papyri from the mid-first to the mid-second centuries CE, papyri from the mid-third century CE, and Diocletian's price edict of 301 CE. Encouragingly, all three data sources yield closely convergent daily 'wheat wages' of 3.7, 3.8, and 3.6kg, respectively.[37] We use 3.7kg per day and multiply it with 225 or 250 work

[35] Scheidel (n.22), table 1 (HS1-1.15); Rathbone (n.22) (HS1.2).
[36] Temin (n.2), 44, 46.
[37] Scheidel (n.22), table 3. These wages, moreover, fall squarely in the middle of the range from 2.7kg to 5 kg of wheat equivalent that is typical of most ancient and medieval economies for which there is evidence, tabulated ibid. table 4.

days to establish annual income. Goldsmith's assumed employment rate of 40 percent seems reasonable given probable demographic conditions.[38] Non-labor income is represented by notional elite income (*c.*HS4bn) as estimated below in Section III plus notional state and municipal revenue (*c.*HS1bn) established above, both of which are converted into wheat equivalent using a range of plausible prices. The result is expressed in both aggregate and per capita terms and then converted into cash, once again using a range of wheat prices (Table 4).

Table 4 Estimate of GDP in wheat equivalent income

Mean daily wage	3.7kg
Working days per year	225-250
Mean annual wage	833-925kg
Labor participation rate	40 percent
Mean labor income per capita	333-370kg
Population	70m
Aggregate labor income	23.3-25.9bn kg
Aggregate non-labor income (cash)	HS 5bn*
Aggregate non-labor income (wheat)	
@ HS 2/modius	16.4bn kg
@ HS 2.5/modius	13.1bn kg
@ HS 3/modius	10.9bn kg
Aggregate total income	34.2-42.3bn kg
Total mean income per capita	489-604kg
Aggregate total income in cash	
@ HS 2/modius	HS 12.1-12.9bn
@ HS 2.5/modius	HS 13.9-14.9bn
@ HS 3/modius	HS 15.7-16.9bn

* transferred from Section III (below)

This somewhat cumbersome procedure minimizes the problems of *a priori* reasoning that undermine existing calculations but nonetheless suffers from (at least) three potential shortcomings. First of all, and most generally, it shares with other attempts the problem that it is predicated on the tacit notion that unskilled workers' wages equaled the mean income enjoyed by subsistence farmers who formed the overwhelming majority of the population. There is nothing we can do to address this issue beyond noting the fact that economists adopt the same simplifying assumption. Secondly, elite income is represented by a single figure rather than a range (see below): however, this does little to affect the predicted ranges. And thirdly, our estimate is bound to understate actual GDP because it does not allow for incomes beyond the elite, base-level workers, and state agents, that is, for skilled workers and 'middling' groups such as craftsmen and merchants. This suggests that the suggested range of 34-42m tons of wheat equivalent probably falls short of actual aggregate income and is therefore best understood as a lower limit, albeit as one that need not have been very far below actual levels.

[38] Cf. Maddison (n.2), 61-2.

GDP Estimates Based on Income Ratios

Data and estimates presented in a sweeping comparative study of income inequality in fourteen preindustrial societies by the economists Branko Milanovic, Peter Lindert, and Jeffrey Williamson provide us with the means to introduce a novel way of estimating Roman GDP.[39] In most of the premodern economies they reviewed, the ratio of the annual wage for unskilled labor to mean per capita GDP and the ratio of minimal subsistence requirements to mean per capita GDP both tended to fall within a relatively narrow range. In other words, per capita GDP failed to exceed basic subsistence or unskilled wages by a very wide margin. By contrast, the most advanced preindustrial economies (the Netherlands and England) as well as modern economies are characterized by significantly wider spreads. These findings can be used to estimate the probable size of Roman GDP and more generally to demarcate the limits of what may plausibly be assumed for an ancient economy.

In a sample of six premodern economies studied by Milanovic and associates (Byzantium *c.*1000, Naples in 1811, India *c.*1750, Old Castille in 1752, Brazil in 1872, and China in 1880), the mean annual income of the average member of the family of a landless peasant – that is, an unskilled rural laborer – equaled between 50 and 76 percent of mean per capita GDP (that is, a wage/GDP ratio of 0.5-0.76).[40] If we follow them in setting the income of such workers at 30 percent above minimum subsistence, represented by the net 'bare bones' level of 335kg (Table 2) and using wheat equivalent values to avoid cash denominations, we obtain, for the Roman Empire, a mean income of 436kg and an implied per capita GDP range from 574kg to 872 kg of wheat equivalent, or 40-61bn kg overall.[41] The mean/median wage/GDP ratio of 0.64 derived from the six case studies suggests a 'central' estimate of 681kg per capita or 48bn kg overall. This is similar to our consumption-based estimate of 620kg and higher than our income-based 'lower-threshold' estimate of 490-600kg (Tables 2 and 4). These figures contrast strongly with the wage/GDP ratio of 0.21 to 1 for England in 1688 and of 0.31 to 1 for England in 1801/3.[42] At those ratios, Roman per capita GDP would have been as high as 1,406kg to 2,076 kg, for a total GDP of the order of 98bn to 145bn kg of wheat equivalent. As there can be no doubt that the Roman Empire as a whole was less developed than England at either one of these dates (see above, p.5), actual Roman GDP must have been considerably lower, a notion that once again meshes well with our other estimates.

A complementary measure focuses on the relationship between minimum subsistence and mean per capita GDP. In a sample of eight countries (Byzantium *c.*1000, Old Castille in 1752, Nueva Espana in 1790, Bihar, India, in 1807, Naples in 1811, Brazil in 1872, China in 1880, and India in 1947), mean per capita GDP amounted to between 1.3 and 1.9 times minimum per capita subsistence.[43] Roman subsistence may be set at 335kg of wheat equivalent net of tax and investment, 360kg including investment but not tax, or 390kg including both. Thus Roman per capita GDP may have amounted to anywhere from 436kg to 741kg of wheat equivalent, for a GDP of 30bn to 52bn kg.[44] Once again, the corresponding ratios for the Netherlands in 1561 (where mean per capita GDP reached 2.8 times subsistence) and 1732 (5.1 times) as well as for

[39] Milanovic, Lindert and Williamson (n.2).

[40] Ibid. 71. We exclude their ratios for the Roman Empire (relying as they do on Goldsmith's flawed assumptions) as well as for Nueva Espana in 1790 and India in 1947 that represent extreme outliers. For a more detailed study of Byzantium, see Milanovic (n.3).

[41] That is, 335kg + 30 per cent = 436kg times 1.32 (for a wage/GDP ratio of 0.76) = 574kg, or 436kg times 2 (for a wage/GDP ratio of 0.5) = 872kg.

[42] Milanovic, Lindert and Williamson (n.2.), 71.

[43] Ibid. 77. In a more recent update, dated November 2008, they also estimate ratios of 2.1 for England and Wales *c.*1290 and 1.5 for South Serbia in 1455. We are grateful to Branko Milanovic for sharing this information with us.

[44] The lowest value is 335kg times 1.3 = 436kg and the highest is 390kg times 1.9 = 741kg.

England in 1688 (3.5 times) and in 1801/3 (5.0 times) serve as a check on our assumptions about Roman GDP. Even at the lowest of these ratios, Roman per capita GDP would have been 938kg, or 66bn kg overall, which means that the actual level was probably lower.

Results: Constraints and Convergence

Our different estimates have served different purposes: to find a 'bottom' by adopting starting assumptions that are likely to understate actual income or consumption; to set a 'ceiling' by vetting overtly optimistic scenarios; and to establish a plausible – if often generously wide – range of target values. The results of these estimates can now be juxtaposed in order to determine the probable size of the Roman economy (Table 5). What catches the eye is the broadly convergent nature of all our previous estimates.

Table 5 Convergent constraints on GDP estimates (expressed in billion kg of wheat equivalent)

Estimate	Much higher than	Somewhat higher than	Suggested range	Not more than	Lower than
Expenditure (Table 2)	27	43		66	
Income (Table 4)		34-42			
GDP/Wage ratio			40-61		98
GDP/Subsistence ratio			30-52		66

At somewhere around 45bn to 50bn kg of wheat equivalent in real terms, GDP in cash might in theory have been as low as HS14-15bn if wheat is priced at HS2 per *modius*, yet this price is so close to Egyptian levels that it is arguably too low as an empire-wide mean. At HS3 per *modius*, GDP would have been considerably higher at HS21-23bn. However, at almost twice the Egyptian rate, this price might be considered high. Alternatively, a notional intermediate mean wheat price of HS2.5 per *modius* would yield a GDP of HS17-19bn. We conclude that the economic product of the Roman Empire at its peak approached 50m tons of wheat equivalent or somewhat less than HS20bn and is highly unlikely to have fallen short of or to have exceeded these figures by a margin of more than 20 percent.[45]

This final estimate allows us to compare Roman economic performance to that of other historical systems. Maddison provides a series of per capita GDP estimates for a variety of economies around the world during the past 2,000 years.[46] Although most of these estimates are necessarily highly conjectural in nature, his figures for parts of Europe and Asia in recent centuries command a measure of confidence and may be set against our estimate of Roman GDP. Standardizing his estimates in 1990 Geary-Khamis dollars to ensure global comparability, Maddison put (generic) annual minimum subsistence at $400 per capita. If, in the Roman Empire, subsistence was 390kg of wheat equivalent, this means that Roman per capita GDP (at *c.*680kg) was around $700. Alternative estimates of the subsistence minimum advocated by other scholars tend to fall in the $350-400 range.[47] At $350, Roman per capita would drop to around $610.

[45] In the following we use notional tallies of 47.5bn kg of wheat equivalent or HS18bn for computational purposes. Much higher or lower values would require a much larger or smaller overall population, which is theoretically possible but would not invalidate the procedures followed to arrive at our present estimate.
[46] Maddison (n.2), 382 table A.7.
[47] See the references in Milanovic, Lindert and Williamson (n.2), 15 n.11.

A different method yields similar results. British mean per capita income was about 1,550kg of wheat equivalent in 1688, compared to perhaps 680kg in Rome. As Maddison puts English GDP in 1688 at $1,411 in 1990 Geary-Khamis dollars, Roman per capita GDP, extrapolated from English GDP, would have been about $620, which falls within the aforementioned range from $610 to $700.[48] At this level, Roman GDP is not far below Maddison's estimates of $714 for England and $761 for the Netherlands in 1500, prior to the flowering of the Dutch Golden and the English Elizabethan Ages, but remains substantially lower than for 1600 ($974 in England and $1,381 in the Netherlands). Other comparanda in the $610-700 range include Germany and Spain in 1500 or Mexico in 1870. Per capita GDP in India did not exceed $619 as recently as 1950. Finally, it is worth noting that Milanovic's detailed study of Byzantine income around 1000 CE yielded a per capita GDP estimate of $680-770, similar to our own estimate for the Roman Empire.[49] All this is consistent with the notion that Roman economic performance approached the ceiling of what was feasible for ancient and medieval economies and their more recent counterparts in the Third World but failed to anticipate even the early stages of the path toward modern economic development. This, in turn, meshes well with our earlier observation that many of the features that characterized the earliest 'modern' economies were absent from the Roman world (see above, p.5).

III INCOME DISTRIBUTION

Public Sector and Elite Income

A key issue for social historians is the question how far the Roman world was dominated by a tiny, plutocratic minority. Rather than apply the generic terms 'rich' and 'poor' we will consider the income of broad status groups – the senatorial elite, the equestrian order, the civic notables, and so on – asking of each, how big a share of the pie did each group control?

We begin by considering the share of the imperial state. Given a GDP of somewhere around HS17-19bn, annual state expenditure of approximately HS900m would have represented an effective tax rate of approximately 5 percent of GDP, which is the same as for France in 1700.[50] This finding confirms Hopkins's claim that the imperial government did not capture more than 5 to 7 percent of GDP and that Roman taxes were fairly low.[51] The overall public sector share of GDP was somewhat larger depending on the scale of municipal spending while the overall nominal tax rate had to be higher still in order to accommodate taxpayer noncompliance, tax amnesties, and rent-seeking behavior by tax collectors and other intermediaries. Moreover, we must not forget that Italy's immunity from output and poll taxes required the public sector share in the provinces to exceed the empire-wide average.[52] These various adjustments allow us to reconcile our GDP estimate with reported nominal taxes of around 10 percent of farm output on

[48] For England, see Maddison (n.2), 51, with 62. Our calculation is meant to replace that proffered by Maddison 52 who compared Roman wheat equivalent to a weighted grain equivalent for England. His attempt to derive Roman GDP from incomes expressed gold (ibid. 51) strikes us as unhelpful as the real value of precious metals changed considerably over time.

[49] Milanovic (n.3), 468.

[50] For the probable size of the imperial budget, see above, n.26. For France, see Goldstone (n.31), 205 table 8.

[51] Hopkins 1980 (n.2), 120-2; 1995/6 (n.2), 47 = 2002 (n.2), 201; 2009 (n.2), 183-4.

[52] See Maddison (n.2), 47-51 for higher mean income in Italy due to a higher concentration of elite incomes and tax (and rent) transfers from other regions. This issue and its implications for the tax regime merit further investigation.

private land reported in Roman Egypt and somewhat higher rates in less developed regions where enforcement may have been more difficult.[53]

An appreciation of the approximate size of aggregate elite income is vital for estimating the degree of economic inequality within the Roman Empire and more specifically the scope for non-elite incomes beyond the subsistence level. Table 6 summarizes existing scholarship on this topic by comparing the conjectural breakdowns envisioned by Goldsmith, Milanovic and associates, and Maddison, and introduces our own revised estimates.[54]

Table 6 Estimates of Roman elite income

		Population	Fortune (Mean)	Income (Mean)	Income (Total)
Senatorial order					
	Goldsmith	600	2.5m	0.15m	90m
	Milanovic	600	2.5m	0.15m	90m
	Maddison	600	2.5m	0.15m	90m
	Revised	600	>5m	>0.3m	>180m
Equestrian order					
	Goldsmith	40,000	0.5m	0.03m	1,200m
	Milanovic	40,000	0.5m	0.03m	1,200m
	Maddison	40,000	0.5m	0.03m	1,200m
	Revised	20,000+	>0.6m	>0.04m	>720m
Decurional order					
	Goldsmith	360,000	0.2m	0.008-0.012m	<3,000m
	Milanovic	360,000	0.13m	0.008m	2,880m
	Maddison	240,000	0.14m	0.008m	2,000m
	Revised	130,000	>0.15m	>0.009m	>1,170m
Other wealthy					
	Goldsmith	-	-	-	-
	Milanovic	200,000	0.32m	0.019m	3,800m
	Maddison	50,000	0.37m	0.022m	1,100m
	Revised	65-130,000	>0.15m	>0.009m	>585m
Elite total					
	Goldsmith	400,000			4.2bn
	Milanovic	600,000			8bn
	Maddison	331,000			4.4bn
	Revised	215,000-290,000			~ 3bn-5bn

[53] E.g., L. Neesen, *Untersuchungen zu den direkten Staatsabgaben in der römischen Kaiserzeit (27 v. Chr. – 284 n. Chr.)*, 68-70; R. Duncan-Jones, *Structure and Scale in the Roman Economy* (1990), 187-90, with (n.25), 47-9.

[54] Goldsmith (n.2), 276-9; Milanovic, Lindert and Williamson (n.2), 64-5; Maddison (n.2) 48-50.

Elite share as a proportion of all households and total income (in percent)

Goldsmith	2.9	20
Milanovic	4.3	37.8
Maddison	3	26.4
Revised	1.2-1.7	~ 16-29

Each of these estimates entails three steps: an estimate of group size, an estimate of group-specific mean wealth, and an extrapolation from wealth to annual income. The last of these steps requires the least amount of discussion. The conventional practice of putting mean annual (net) income at 6 percent of wealth is supported by a variety of ancient sources.[55]

As Table 6 shows, previous estimates agreed on the aggregate incomes of the top two status echelons, the senatorial and equestrian orders. This agreement, however, rests on nothing more than unquestioning acceptance of Goldsmith's initial assumptions, which are in need of revision. While the number of senators can with some confidence be set at around 600 during the early monarchical period,[56] their mean wealth and income have been seriously underestimated. Observers have been fixated on the census threshold of HS1m that was a prerequisite for membership in the senatorial order and consequently set probable mean wealth relatively close to this minimum. This procedure neglects the fact that at the very top of the income distribution, median and mean incomes tend to diverge sharply, and therefore fails to account for super-rich senators. To give a simple example, a single individual with a fortune of HS300m would have raised the overall mean for each of 600 senators by half a million sesterces.[57] If mean senatorial wealth is put at a mere HS2.5m but Pliny the Younger was worth some HS20m and there had been just a few dozen others like him, the overwhelming majority of all senatorial fortunes would have barely risen above the legal minimum of HS1m, which is not a plausible scenario.[58] Hence, even if median incomes did not rise far above the formal threshold, we must nevertheless allow for significantly larger average senatorial wealth and income.

Estimates of equestrian wealth are even more difficult to justify for the simple reason that total group membership is unknown. Literary references to the presence of 5,000 or 20,000 knights at a single event, or of 500 of them residing in a single town, may or may not be reliable; such reports defy verification.[59] The figure of 40,000 preferred by Goldsmith and others is

[55] We agree with the findings and arguments of Duncan-Jones (n.23), 33, 133-5. Although higher-risk investments were associated with higher interest rates (12 per cent rather than the usual 5-6.7 per cent reported for many charitable foundations), such investments would not always have yielded the expected return; and moreover a certain proportion of elite wealth was tied up in non-productive assets without generating regular returns at all. All this suggests that the margins of uncertainty are moderate and that actual average yields did not greatly exceed the conventional rate of 6 per cent.

[56] See R. J. A. Talbert, *The Senate of Imperial Rome* (1984), 131-4.

[57] For examples of private wealth on that scale, see Duncan-Jones (n.23), 343-4.

[58] For Pliny, see Duncan-Jones (n.23), 17-32. For senatorial wealth in general, see I. Shatzman, *Senatorial Wealth and Roman Politics* (1975); S. Mratschek-Halfmann, *Divites et praepotentes* (1993); A. M. Andermahr, *Totus in praediis* (1998). Some senators of course barely reached the minimum or relied on the emperor to make up the difference: Talbert (n.54), 52-3.

[59] See briefly Scheidel (n.3), 50 (Plut. *Cic.* 31.1: 20,000 knights supported Cicero; Dion. Hal. 6.13.4: 5,000 knights annually paraded under Augustus; Strab. 3.5.3, 5.1.7: Gades and Patavium each boasted 500 knights), and the literature cited by Goldsmith (n.2), 277 n.69. Even if Gades or Patavium (with their territories) had each had a very large population of 100,000, or 20-25,000 households, there would have been one equestrian family for every 40 to 50 households, a strikingly low ratio. If these figures are correct and not just hyperbole, and if average cities were only one-tenth as wealthy as those two, there would have been 35,000 equestrian families in the empire as a whole. But the reported figures seem very large as well as suspiciously round, although they do not involve the more conventional symbolic figure of '400.'

therefore a mere guess. All we can say is that given the number of cities (around 2,000) and city-councilors in the Roman Empire (see below), the actual total was probably in five figures. For the purposes of this study, we adopt a total of 20,000 as a conservative estimate, equivalent to 10 persons of equestrian wealth per city (that is, a few or none for smaller towns and dozens for larger ones, and perhaps hundreds in highly exceptional cases).[60] Although a larger total remains possible, the probable number of *decuriones* imposes serious constraints on more generous estimates (see below), given that non-equestrian *decuriones* ought to have outnumbered equestrians by a wide margin. The question of mean equestrian wealth is similarly difficult to address. Goldsmith, once again followed by others, reckoned with a very low average fortune of HS500,000, which is only 25 percent above the minimum census threshold of HS400,000.[61] Just as in the case of senators, this mean is bound to be too low. We must bear in mind that membership in this group was not narrowly determined by wealth in the sense that only individuals with estates between HS400,000 and HS1m qualified whereas richer ones would somehow automatically join the senatorial ranks. In reality, the *ordo senatorius* was merely a small subset of a much larger group of individuals of equestrian wealth and status, which suggests that a certain proportion of equestrian fortunes would have exceeded the senatorial census threshold.

The *ordo decurionum* poses similar problems. Once again, its size is unknown. Even if we settle for a rough estimate of about 2,000 cities in the empire we cannot simply multiply this figure with a certain number of city councilors to arrive at a grand total. One reason is that city councils in the western half of the empire varied significantly in size: two templates, with 100 full members in larger cities and 30 in smaller ones, appear to have been common.[62] If we schematically reckon with 500 'large' cities with 100 city councilors each and 500 'small' cities with 30 each (many of them in Italy), we obtain a tally of 65,000 decurions for the western half of the empire.[63] To make matters worse, it is unknown if a property threshold of HS100,000 applied across all municipalities: the fact that recorded fees paid to obtain public office or council membership (*summae honoriae*) varied by a factor of 50 or perhaps even 100 between the largest and smallest cities casts doubt on the notion of uniform standards.[64] Then again, variation in the size of councils may speak against dramatic differences in property qualifications, since otherwise smaller towns might simply have appointed 100 councilors of correspondingly lower wealth. Another major problem arises from the fact that several cities in the eastern half of the empire are known to have had councils of well in excess of 100 members: reported tallies range from 60 and 100 to 450 and 500 or even more in Asia Minor alone, or 600-1,200 in late Roman

[60] Note that the Trajanic alimentary tables record 9 estates with values above the equestrian census threshold in Veleia but only 2 in Ligures Baebiani: Duncan-Jones (n.23), 211. Jongman 2006 (n.1), 248 n.35 reckons with a minimum of 5,000 knights in Italy but none elsewhere, which must be far from the truth.

[61] However, Goldsmith (n.2), 278 wrongly interprets this figure as twice a minimum threshold of HS250,000.

[62] See Duncan-Jones (n.23), 283-4.

[63] W. Jongman, *The Economy and Society of Pompeii* (1988), 193 n.5 reckons with 100 cities of 100 councilors each and 330 cities of 30 councilors each, for a total of 20,000 in Roman Italy. Italy had a disproportionately large share of small towns. Towns in Gaul and parts of Spain were less numerous and had larger territories. This accounts for our very rough split. Somewhat different distributions, such as 333 large cities and 667 small ones, would not make a big difference (resulting in 53,300 instead of 65,000 decurions). Jongman 206: 248 n.35 multiplies his estimate for Italy by 5 to scale up to the entire empire, for 100,000 decurions overall. This seems too low because it applies the large share of small towns in Italy to other provinces and neglects the larger councils in the East (see below).

[64] See Duncan-Jones (n.23), 82-8.

Antioch.[65] This, however, does not necessarily mean that such cities were wealthier overall or absorbed a larger share of the wealthy into their councils: it may simply reflect a greater degree of inclusiveness in the 'Greek' or Hellenized communities of the eastern Mediterranean. This notion is supported by the observation that eastern towns that were granted Roman status ended up with councils of 100 members.[66] For our present purposes, it may therefore be legitimate to presuppose the existence of a notional 'core' group of councilors, in the sense of a group that equaled its western counterparts in terms of income, and extrapolate its size from that surmised for the western half of the empire. This conjecture yields some 130,000 individuals of decurional wealth for the entire empire. Needless to say, we have no idea how their fortunes were distributed: some of them may well have been large, nominally sufficient for equestrian status – given that both Gades and Padua were each credited with 500 equestrians[67] – or perhaps even for senatorial rank.

Not all of the rich belonged to one of these three orders. Persons of inadequate pedigree were barred from joining them but might nevertheless dispose of considerable resources; wealthy freedmen are the most obvious example. The latter dominated the Augustales, a group of notables who came to be organized in an *ordo* that – in status terms – occupied a middle ground between the *decuriones* and the generic *plebs*. According to a tiny sample of epigraphic records, the number of Augustales might correspond to anywhere from as few as one-fifth to as many as more than twice the number of decurions of a given town, and there is no strong reason to assume that they were much, if at all, poorer than the more 'honorable' city councilors.[68] Thus, a rough guess that puts the number of non-decurional households that enjoyed decurional income levels at one-half of that of the total number of decurions would seem to be a minimum.[69] Yet they may well have been more numerous, perhaps even rivaling the *ordo decurionum* in size.[70]

While consideration of these various points of detail serves to put earlier estimates into perspective, it must not distract us from a more crucial point. The main shortcoming of existing work on this topic is that it treats different segments of the imperial elite as discrete entities that can be defined in economic terms. This approach neglects the quintessentially legal nature of the status distinctions between senators, knights and decurions that need not have neatly corresponded to graduations in wealth. We propose to estimate elite income by considering the imperial elite *in toto*. This alternative approach not only keeps us from getting bogged down in

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[65] See T. R. S. Broughton, 'Roman Asia Minor', in *ESAR* IV (1938), 814 (60 in Cnidus, 100 in Halicarnassus, 450 in Ephesus, 500 in Oenoanda, and 500-650(?) in Thyatira); W. Langhammer, *Die rechtliche und soziale Stellung der* Magistratus municipales *und der* Decuriones ... (1973), 190 n.9 (Antioch).

[66] Thus Langhammer (n.63), 190.

[67] See above, n.57.

[68] Duncan-Jones (n.23), 284-6. In cases in which both the number of councilors and the number of Augustales are known or can be inferred, the latter amounted to 18-20 percent, 60-67 percent, 173-218 percent, and 250 percent of the former. It is manifestly impossible to deduce an average ratio from these wildly divergent tallies. The most detailed study of the Augustales is A. Abramenko, *Die munizipale Mittelschicht im kaiserzeitlichen Italien* (1993).

[69] The presence of 25 *pedani* in addition to 100 *decuriones* in the *album* of Canusium (a roster of an Italian city council from 229 CE) and the election of councilors *super legitimum numerum* in Bithynia under Trajan likewise speak in favor of a larger elite.

[70] Even so, we must question the estimate by Milanovic and associates that envisions 200,000 additional wealthy people with average fortunes that fall in between their own estimates for equestrian and decurional wealth and a consequently very large aggregate annual income of close to HS4bn (see Table 6). While this generous scenario cannot strictly speaking be ruled out, it entails implausible corollaries, implying as it does the presence, on average, of 100 non-decurional individuals of above-decurional wealth per city. This would mean that the *ordo decurionum* did not represent the economic top tier of any given municipality but merely a minority (in both demographic and financial terms) of all local elite families. This does not seem likely, and their estimate is therefore best regarded as too high.

ultimately fruitless conjectures about the economic properties of different status groups but more importantly enables us to draw on Vilfredo Pareto's famous finding that the distribution of income tends fall into a predictable pattern governed by power laws.[71]

A few simple examples illustrate the potential of this perspective. Pareto's initial finding was that in a number of societies cohort size shrank by five-sixths every times wealth increased tenfold (i.e., people owning x were 6 times as numerous as those owning 10x). It is easy to show that this ratio does not apply to Roman elite wealth. Reckoning with between 215,600 and 290,600 elite households (see Table 6) and a lower threshold of HS100,000, even the lower one of these estimates would translate to total elite wealth of HS573bn or an annual income of HS34bn, far in excess of any credible GDP figure.[72] The actual income pyramid must therefore have been steeper, presumably reflecting limited economic integration within the empire. However, while there is no denying that a power-law distribution need not have applied at all, this working hypothesis is arguably preferable to the arbitrary guesswork favored in earlier scholarship and can be shown to be of great help in demarcating the margins of the possible.

Here is why. Employing a simplified model with a base tally of HS125,000 representing average lower-level decurional wealth, we ask what the elite income distribution would have looked like if the number of households had dropped by a certain percentage every time wealth doubled. For instance, if the number of households had halved every time wealth doubled (i.e., n households at HS125,000 each, n/2 at HS250,000, n/4 at HS500,000, and so on), aggregate elite wealth would have amounted to HS161bn and annual income to HS9.7bn. Over 50,000 households would have met the equestrian property requirement, which seems like an excessively large total relative to the probable number of decurional households. Conversely, if we assume that the number of households dropped by three-quarters every time wealth doubled, we arrive at much smaller aggregate assets of HS40bn and HS2.4bn in annual income, as well as some 13,000 households of equestrian wealth. More extreme assumptions would necessarily produce even higher or lower totals.

These findings speak in favor of some form of intermediate estimate. If the number of households had dropped by two-thirds every time wealth doubled, elite assets would have totaled HS53bn for a population of 215,600 elite households, for an aggregate annual income of HS3.2bn and *c.*24,000 equestrian-level households, or HS72bn for 290,600 elite households, for an annual income of HS4.3bn and *c.*32,000 equestrian-level households. Figure 1 indicates that whereas a reduction by one-half every time wealth doubles produces too many super-rich households and a reduction by three-quarters every time wealth doubles thins out the upper echelons too much, a reduction by two-thirds every time wealth doubles yields a historically plausible ceiling.

[71] See J. Persky, 'Pareto's law', *Journal of Economic Perspectives* 6 (1992), 181-92 for a survey of the debate. For an application to the Forbes 400 (i.e., the 400 richest persons in the United States), see O. S. Klass *et al.*, 'The Forbes 400 and the Pareto wealth distribution', *Economics Letters* 90 (2006), 290-5.

[72] Starting with around 31,800 households at HS100,000 and capping the tally at HS1bn households, we would obtain 185,600 households from HS100,000 to HS1m, 25,600 from HS1m to HS10m, 4,000 from HS10m to HS100m, and 400 from HS100m to HS1bn. This suggests more than 30,000 families of senatorial wealth, and an impossible number of super-rich individuals.

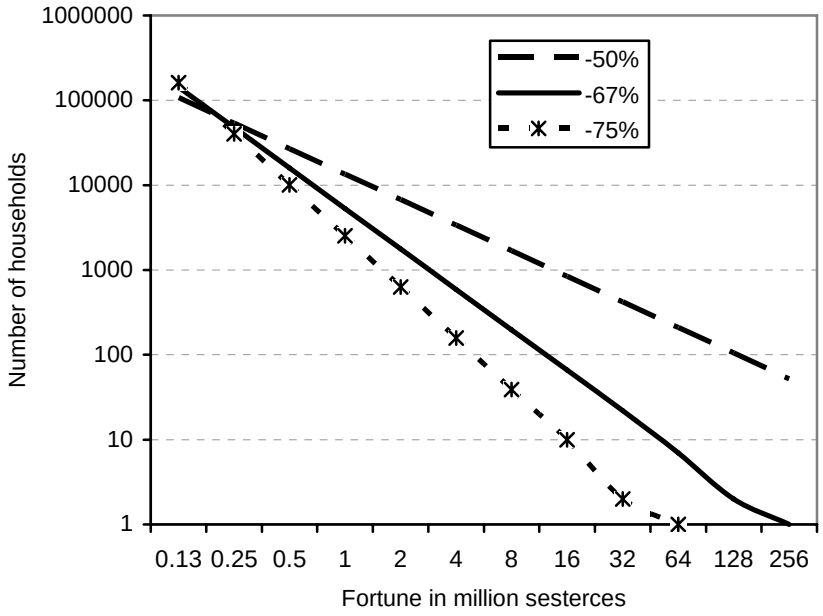

Figure 1 Power-law distribution of elite households by income (logarithmic scale)

We use the term 'plausible' because this cannot be a question about which of our crude simulations is 'correct': none of them is. The question must be which simulation is more likely to approximate reality than its alternatives. Our intermediate ('two-thirds') simulation meets this requirement for five separate reasons.

(1) It is consistent with our critique of existing estimates in that it accommodates what we would consider reasonable minimal values of group size and wealth. It allows us to raise mean senatorial wealth well above 2.5 times the legal threshold and equestrian and decurional mean wealth to at least 1.5 times the minimal census requirements. For example, mean senatorial wealth of HS5m would translate to HS180m in aggregate annual income; mean equestrian wealth of at least 1.5 times the required minimum would yield annual incomes of HS720m+ for 20,000 households or HS1.08bn+ for 30,000; mean decurional wealth of at least 1.5 times HS100,000 would translate to an annual income of HS1.17bn+; 65,000-130,000 additional elite households equal to decurional wealth would earn another HS585m+ to HS1.17bn+. The resultant overall minima of HS2.7bn in annual income for 215,600 people and HS3.6bn for 290,600 fall somewhat short of our intermediate power-law estimate of HS3.2-4.3bn, which is precisely what we would expect from estimates that are meant to denote income minima.

(2) It predicts maximum individual household wealth of around HS250m, a figure that is much more compatible with the historical record than the ceilings of HS64m or HS16.4bn (!) implied by the other two simulations.

(3) It predicts a superficially plausible number of households of equestrian wealth and an actual *ordo* of some 20,000 to 30,000 members, whereas rival models imply significantly smaller or larger totals which are more difficult to reconcile with the admittedly poor record.

(4) It suggests that the richest 1 percent of households captured a share of total income that is consistent with a wide range of comparative evidence. Thus, if we reckon with 215,600 elite households, the top 1 percent of all households in the empire would have earned HS2.9bn per year, or around 16 per cent of GDP, and if we reckon with 290,600 elite households, the tally

would have been HS3.5bn or 19 percent of GDP.[73] This bracket compares well with Milanovic and associates' (more or less conjectural) rates of 11.2 percent in Brazil in 1872, 11.5 percent in Bihar, India, in 1807, 14 percent in India in 1947, 14.3 percent in Naples in 1801, 15 percent in Mughal India in 1750, 21.1 percent in Nueva Espana in 1790, and 21.3 percent in China in 1880.[74] In the most general terms, this indicates that our minimal and maximal estimates for the Roman Empire demarcate a historically plausible range and are therefore unlikely to be far too low or high.

(5) An important check on our conjectures is provided by the fact that all these guesstimates are logically interconnected. For instance, if it is accepted that is unlikely that there were many more than 130,000 decurions with a minimum wealth of HS100,000, it is also unlikely that there were, say, 60,000 instead of 20-30,000 knights, given that knights can be expected to have been much rarer than mere decurions. This, in turn, ought to dissuade us from adding hundreds of thousands of households of curial wealth that did not belong to the three orders. Moreover, our conjectures regarding aggregate elite income are ultimately constrained by our convergent estimates of total GDP, most of which (with the exception of the income-based estimate) were derived without reference to elite income and are therefore independent of any of the conjectures advanced in this section. This means that at some point it becomes simply impossible to expand elite income without crowding out everybody else.

We conclude that our revised estimates set forth in Table 6 are both mutually consistent and consonant with comparative evidence. Even so, they inevitably retain a fair amount of elasticity. We propose a minimum total elite wealth of at least HS3bn, a level that may well have been exceeded by one or two billion sesterces. For instance, at a mean return of 7 instead of 6 percent our higher estimate rises to HS5bn, illustrating the considerable margin of error. It is by coincidence and not by design that this range accommodates earlier estimates by Goldsmith and Maddison, given that we disagree with several of their starting assumptions.[75]

A range of HS3-5bn will therefore be used for rough computational purposes. In this scenario, elite income would have accounted for anywhere from 15 to 30 percent of total income. With the state and communities absorbing at least another billion, non-elite civilians would have disposed of HS11-14bn per year, for an average household income of HS650-825 or, at a notional conversion rate of HS2.5 per *modius*, of 1,700-2,160kg of wheat equivalent, which works out at 425-540kg per capita.[76]

[73] Based on Table 6. The low-end estimate consists of 600 senatorial households with an income of HS240m + 20,000 equestrian households with HS750m + 130,000 decurional households and 24,400 other rich households with HS1,488m = HS2,478m. The high-end estimate consists of 600 senatorial families with HS330m + 40,000 equestrian households with HS1.8bn + 130,000 decurional households and 4,400 other rich households with HS1,478m = HS3,608m. We schematically reckon with 17.5m households for the entire empire.

[74] Milanovic, Lindert and Williamson (n.2), 78 table 3. They also provide an estimate of 30.6 percent for Byzantium *c.*1000 which is necessarily highly uncertain. Their own estimate of 16.1 percent for the Roman Empire in 14 CE rests on the flawed starting assumptions critiqued above.

[75] See Table 6. Note that Goldsmith (n.2), 278 considered his estimate of elite wealth a minimum, and cf. the criticism by Maddison (n.2), 47. By contrast, as noted above, the estimate advocated by Milanovic and associates appears to be too high even if we make proper allowance for the considerable uncertainties involved in this kind of exercise.

[76] This range compares well with a military base stipend of HS1,200, or about 1½ times average non-elite household income accruing to a single adult man.

Non-Elite Income

What does an annual mean net private per capita income of 425-540kg of wheat equivalent tell us about non-elite income stratification? Our consumption-based estimate at the 'bare bones basket' level (Table 2) yielded a mean private income of about 360kg of wheat equivalent per person (exclusive of tax), suggesting that actual mean non-elite income was between one-fifth and one-half higher than basic subsistence.[77] In the following, we operate with two limiting scenarios, a 'pessimistic' estimate (i.e., 'pessimistic' with respect to the scale of non-elite consumption) of 425kg and an 'optimistic' version of 540kg, and explore their implications for income stratification.

Our model seeks to delineate the potential structure of Roman income distribution with the help of a basic scale of income brackets instead of simply averaging putative group-specific income (Table 7).[78] This scale groups the population in uniformly sized income brackets termed 'levels'. Each level covers income variation per person of up to 655kg of wheat equivalent, that is, from 0 to 655kg (Level 0), from 655 to 1310kg (Level 1), from 1310 to 1965kg (Level 2), and so on. Our scale is anchored in an annual elite per capita income threshold of 3,930kg of wheat derived from the conventional decurional property requirement of HS100,000, which is divided by 4 to translate to mean individual income and expressed in wheat equivalent at a conversion rate of HS2.5 per *modius*. This threshold separates Levels 6+ ('elite') from Levels 0-5 ('non-elite'). Our schedule greatly refines Stephen Friesen's earlier 'poverty scale' that disaggregated Roman society into seven more loosely defined income groups.[79] We identify measures of gross income inclusive of the public sector share and investment, which – where noted – translates to different subsistence levels ('gross' or inclusive of tax and investment, and 'net' or exclusive of these elements) in the right-hand column of Table 7.[80] This requires our bounding estimates of 425kg and 540kg of wheat equivalent for mean annual per capita non-elite income to be adjusted to 460kg and 575kg in order to accommodate the public sector share.[81]

[77] We note in passing that this observation alone speaks against the notion that elite income could have been substantially higher, as envisaged by Milanovic and associates.

[78] For an earlier much cruder distributional model for the entire empire, cf. Milanovic, Lindert and Williamson (n.2), 64.

[79] Friesen (n.3), 337-47 (imperial elites; regional/provincial elites; municipal elites; moderate surplus resources; stable neat subsistence; at subsistence; below subsistence).

[80] In the absence of further specification, our entries refer to gross income.

[81] The public sector share is put at *c.*37kg per capita and all adjustments are rounded. Our estimate of non-elite per capita income also includes investment: while one may assume that elite households accounted for a disproportionate share of total investment, even the poor made investments, for instance by acquiring basic tools, and due to their modest circumstances even small investments would have represented a non-trivial share of per capita income. We adopt the simplifying assumption that the public sector share (in percentage terms) was the same for elites and non-elites: while this is not verifiable, different assumptions would do little to change the overall means used here.

Table 7 Non-elite income scale

Level	Wheat (in kg)	Characteristics
5	3275-3930	8.4-10 times subsistence
4	2620-3275	6.7-8.4 times subsistence
3	1965-2620	5-6.7 times subsistence
2	1310-1965	3.3-5 times subsistence
1	655-1310	1.7 to 3.3 times subsistence *c.*940kg: 'respectable' gross income* *c.*850kg: 'respectable' net income* *c.*750kg: some grain fed to livestock** *c.*500kg: supports work animals fed by by-products and grasses**
0.75-0.99	491-655	¼ to $^{2}/_{3}$ above subsistence
0.50-0.74	**327-491**	**At or close to subsistence** *c.*390kg: minimal gross subsistence including clothes, fuel and shelter ~ Level 0.6*** *c.*335kg: minimal net subsistence including clothes, fuel and shelter***
0.25-0.49	164-327	Below subsistence <*c.*300kg: minimal net food subsistence**
<0.25	<164	Starvation level

* See Table 2, based on Scheidel (n.22), table 1
** Based on Clark and Haswell (n.14), 64-5
*** See Table 2, based on Scheidel (n.22), table 2

We employ this scale to address a fundamental question: how might non-elite income have been distributed so as to average out at either 460kg or 575kg of wheat equivalent in gross annual per capita income? Tables 8 and 9 offer conjectural answers to this query. Albeit guesswork, these conjectures are in fact fairly inflexible because the non-elite population can only be configured in a narrowly circumscribed variety of ways without exceeding the proposed mean per capita incomes: in any scenario, subsistence-level individuals must greatly outnumber more affluent ones for aggregate income to match the predetermined totals. Thanks to these constraints our schedules cannot deviate very far from actual conditions in an environment in which gross annual per capita income for the non-elite was of the order of 500kg of wheat equivalent. We assume that non-elite individuals accounted for 97 per cent of a total population of 70 million, leaving somewhere around 1.5 per cent each for members of the elite and for military families (who were maintained by the public sector share).[82] For the sake of simplicity, mean income for each level is represented by that bracket's mid-point income.[83]

[82] We assume that military families were somewhat smaller than average. Given their very modest demographic weight their inclusion would not significantly affect the schedules in Tables 8 and 9.
[83] For the notion of average incomes *below* subsistence, see comparative evidence for eighteenth-century France (R. W. Fogel, 'New sources and new techniques for the study of secular trends in nutritional status, health, mortality and the process of aging', *Historical Methods* 26 [1993], 5-43) and more recent developing countries.

Table 8 Civilian non-elite gross income distribution: 'pessimistic' scenario (overall per capita mean ~ 460kg of wheat equivalent per year)

Level	Wheat (in kg)	Percentage of population	Mean per capita income	Aggregate income (in m kg)
5	3275-3930	0.4	3602.5	978
4	2620-3275	0.6	2947.5	1,201
3	1965-2620	1	2292.5	1,557
2	1310-1965	1.5	1637.5	1,668
1	655-1310	3.5	982.5	2,335
0.75-0.99	491-655	8	573	3,113
0.50-0.74	327-491	60	409	16,663
0.25-0.49	164-327	22	245.5	3,667
Total		97	459	31,182

Table 9 Civilian non-elite gross income distribution: 'optimistic' scenario (overall per capita mean ~ 575kg of wheat equivalent per year)

Level	Wheat (in kg)	Percentage of population	Mean per capita income	Aggregate income (in m kg)
5	3275-3930	0.8	3602.5	1,957
4	2620-3275	1.2	2947.5	2,402
3	1965-2620	1.8	2292.5	2,802
2	1310-1965	2.7	1637.5	3,002
1	655-1310	6.5	982.5	4,336
0.75-0.99	491-655	19	573	7,392
0.50-0.74	327-491	55	409	15,274
0.25-0.49	164-327	10	245.5	1,667
Total		97	572	38,832

IV SOCIAL IMPLICATIONS

Overall Income Stratification

If we set the lower limit of what might be considered a 'middling' income at 2.4 times 'bare bones' gross subsistence – in keeping with Scheidel's estimate of the income required to sustain a 'respectable' level of consumption in Roman Egypt (Table 2) –, this threshold would correspond to Level 1.44 on our income scale. Tables 8 and 9 therefore suggest that according to a 'pessimistic' assessment of the non-elite share in total income not more than about 5 per cent of the civilian non-elite population would have enjoyed 'middling' incomes. In an 'optimistic' reading the same would have been true of around 10 percent. If we add ordinary soldiers, who may just have reached that threshold depending on family size, the 'middling' share increases by merely 1 or 2 percentage points. We conclude that in the Roman empire as a whole, a 'middling'

sector of somewhere around 6 to 12 percent of the population, defined by a real income of between 2.4 and 10 times 'bare bones' subsistence or 1 to 4 times 'respectable' consumption levels, would have occupied a fairly narrow middle ground between an elite segment of perhaps 1.5 percent of the population and a vast majority close to subsistence level of around 90 percent. In this system, some 1.5 per cent of households controlled 15 to 25 percent of total income while close to 10 percent took in another 15 to 25 percent, leaving not much more than half of all income for all remaining households.[84]

Table 10 presents what we consider bounding scenarios for the overall income distribution of the Roman Empire in the mid-second century CE.[85] The two columns indicate the probable share of the imperial population that fell in a particular income level (including fractional levels and larger brackets spanning several levels), depending on our assumptions regarding mean per capita gross income at sub-elite levels (*c.*460kg of wheat equivalent in the 'pessimistic' and *c.*575kg in the 'optimistic' scenarios) as set out in Tables 8 and 9.

[84] See below, Table 11. Note that this breakdown is similar (yet somewhat more benign: cf. below, at nn.85-6) to that proposed for late eighteenth-century France where the top 10 percent of income earners captured about one-half of all income: see C. Morrisson and W. Snyder, 'The income inequality of France in historical perspective', *European Review of Economic History* 4 (2000), 74 table 8, and below for similar inequality measures (Gini coefficient).

[85] Among the elite, Levels 6-11 represent household wealth of HS100,000-200,000, defined as lower decurional wealth ranks; Levels 12-23 correspond to household of wealth of HS200,000-400,000, or higher decurional wealth ranks; Levels 24-44, to household wealth of HS 400,000-750,000, or lower equestrian wealth ranks; Levels 45-74, to household wealth of HS 750,000-1,250,000, or higher equestrian and very low senatorial wealth ranks; Levels 75-149, to household wealth of HS 1.25-2.5m, or low senatorial ranks; Levels 150-299, to household wealth of HS2.5-5m, or moderate senatorial ranks; Levels 300-599, to household wealth of HS5-10m, or intermediate senatorial ranks; and Levels 600+ denotes higher senatorial ranks. A complete scale would be much more elongated: for instance, a fortune of HS300m would reach Level 18,000.

Table 10 Conjectural income scale for the Roman Empire, showing the proportion of the total population per income level(s)

Level	Proportion according to	
	'pessimistic'* assessment of non-elite income share	'optimistic'**
600+	0.0008	0.0006
300-599	0.002	0.001
150-299	0.005	0.003
75-149	0.01	0.01
45-74	0.04	0.03
24-44	0.1	0.1
12-23	0.4	0.3
6-11	1.1	0.8
5	0.4	0.8
4	0.6	1.2
3	1	1.8
2	1.5	2.7
1	4.8***	8.3***
0.75-0.99	8	19
0.5-0.74	60	55
0.25-0.49	22	10

* Based on 290,600 elite households
** Based on 215,600 elite households
*** Including military households

In order to make better sense of these figures, it is helpful to visualize the share of total income controlled by a particular proportion of the population. Figure 2a/b tracks the unequal distribution of resources suggested in Table 10, showing at a glance that, for example, the bottom half of households controlled only about one-quarter of total income whereas the top tenth (or, in statistical parlance, the top 'decile') claimed between 30 and 40 per cent of earnings. The dotted line indicates what a perfectly equal income distribution would look like (with 10, 20, 30… per cent of all households controlling 10, 20, 30… per cent of all income).

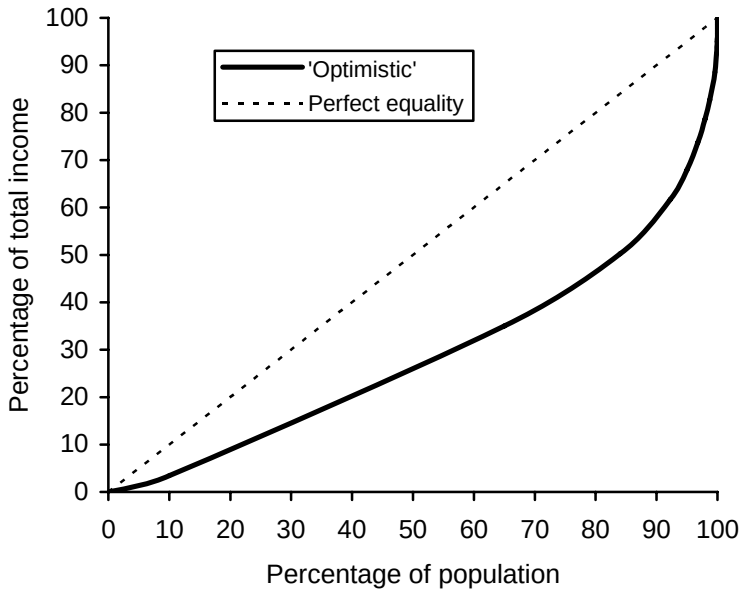

Figure 2a Roman income inequality:
percentage of total income received by percentage of population

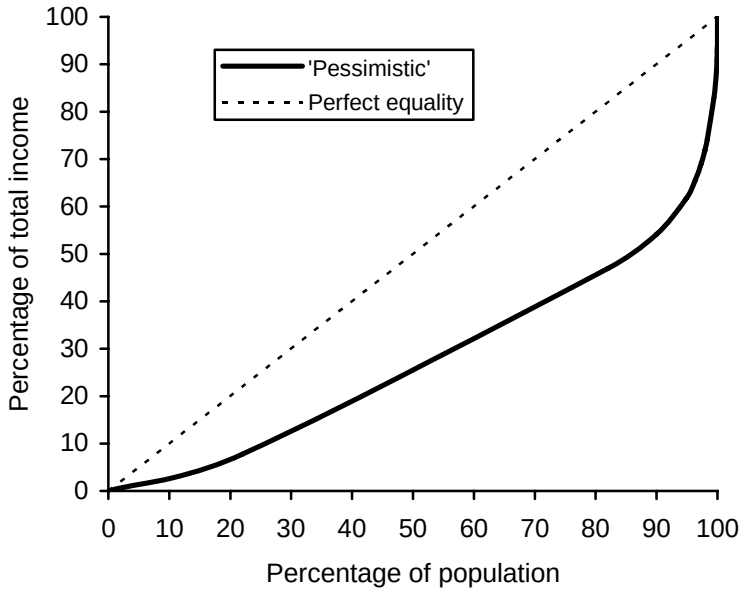

Figure 2b Roman income inequality:
percentage of total income received by percentage of population

This breakdown enables us to calculate the Gini coefficient of income inequality in the Roman Empire.[86] Our two scenarios yield almost identical measures of 0.42 and 0.44. By comparison, Milanovic and associates calculated Gini coefficients for 13 other historical societies ranging from 0.24 to 0.64, with a median of 0.45. This indicates that Roman inequality fell right in the middle of a broad historical range. More importantly, our results are markedly lower than Gini coefficients of 0.52 and 0.59 for Britain in 1759 and 1801, respectively, and of 0.59 for late eighteenth-century France.[87] This is exactly as it should be: if, as it must have been, the Roman economy was less developed than some of the most advanced economies of the eighteenth century, Roman income inequality must have been more limited in scope, given that Gini values are constrained by the level of mean income.[88]

Income-based comparanda from the Roman world are lacking. Gini coefficients of wealth have been calculated for a series of registers of landed property, mostly from Roman Egypt, ranging from 0.43 for villagers in Karanis in the Fayyum in 308/9 CE and 0.44 for the alimentary register of Ligures Baebiani in 101 CE to 0.52 for the Fayyum village of Philadelphia in 216 CE, 0.62 in Aphrodito *c.*525/6 CE, 0.64 for metropolitan landowners in Karanis in the Fayyum in 308/9 CE, and 0.82 for a group of landowners in the Hermopolite nome in the mid-fourth century CE.[89] Unfortunately we are unable to derive income inequality from any of these samples. It is, however, encouraging that these local measures of *wealth* inequality tend to exceed our overall estimate of *income* inequality by a considerable margin since the former generally tends to be more pronounced than the latter.[90]

How Robust Is Our Reconstruction?

Although it is certainly possible to devise a variety of somewhat different distributions that correspond to comparable rates of average income, it is important to realize that the basic pattern is fairly inflexible. Wealthier cohorts inevitably had to be much smaller than poorer ones; not too many households could exist below subsistence levels without paralyzing society; as a consequence, for most households income had to be concentrated relatively close to subsistence. This makes it impossible to alter any of these elements – such as the share of 'middling' income groups – without adjusting a whole series of other variables such as aggregate elite wealth or

[86] The Gini coefficient is a measure of inequality ranging from 0 to 1, where 0 denotes perfect equality (in the sense that each unit of observation commands the same amount of resources) and 1 denotes maximum inequality (in the sense that one person or household monopolizes all resources and none of the others have any). Note that in our schedule, granularity (i.e., the level of resolution) is very poor for lower income groups, a feature which tends to depress the overall Gini coefficient.

[87] Morrisson and Snyder (n.82), 69-70, with further references.

[88] Our Gini coefficient of 0.42-0.44 needs to be related to what Milanovic has termed the 'inequality possibility frontier' (IPF), which represents the maximum degree of inequality that is possible for a given level of surplus production beyond subsistence. At 390kg as gross per capita subsistence and 680kg as mean GDP, Roman IPF would be 0.42 (computed using the equations in Milanovic, Lindert and Williamson [n.2], 10). However, this measure is highly sensitive to the assumed level of subsistence: if we adjust the latter to 335kg (to represent subsistence net of tax and investment) and mean output to 715kg (for total GDP of 50bn kg), IPF rises to 0.52, and at 300kg subsistence and 715kg GDP it reaches 0.57. Under these circumstances, actual Roman inequality may have reached approximately 80 per cent of the theoretical maximum, a finding that chimes well with corresponding values for a wide variety of premodern societies (see ibid. 77).

[89] Duncan-Jones (n.51), 129; Bagnall (n.3), 113, 134-7, summarized in Scheidel (n.3), 52-3.

[90] This is easy to understand: while for a rich person, income may largely be a function of that personal wealth that produces an annual return, a poor person may be virtually property-less but still earn a subsistence income.

overall GDP. Yet elite wealth and income cannot have been much smaller than estimated in Section III without rendering Roman society more equitable (in terms of the top 1 percent income share) than other early historical systems, nor can it have been much larger without crowding out non-elite income. In fact, the only way to arrive at significantly higher non-elite incomes, and hence a larger 'middling' sector, would be by raising total GDP well beyond our estimate at the end of Section II. This estimate, however, is the result of a whole series of largely independent yet convergent measures based on probable expenditure, income, and – arguably most importantly – income ratios drawn from a wide range of other early economies.

In the final analysis, it is not feasible to suppose a much larger (or smaller) GDP, or a much larger 'middling' segment, or much higher elite income, without assuming that the Roman Empire *as a whole* was highly anomalous in world historical terms. Although not all early economies were the same, it was easier for smaller entities (such as city states) to deviate from general norms than for larger ones: accounting as it did for perhaps a quarter of humanity, the Roman Empire cannot, on average, have been strikingly unusual.[91] Our study is intended as much as an exercise in methodology as in the reconstruction of economic output and its distribution. We hope to have shown that even topics that may at first sight appear impervious to meaningful inquiry, such as the size of the Roman imperial economy – an issue alien and unknowable to ancient observers – or the degree of income inequality can in fact be investigated with the help of parametric modeling and controlled conjecture that mesh empirical data with comparative evidence.

Conclusion: Social and Economic Segmentation

The relative robustness of our findings justifies a number of predictions about the structure of demand in the Roman economy. In demographic terms, 'middling' income groups were small, accounting for not more than very roughly one-tenth of the imperial population. This observation, however, does not imply social or economical insignificance. According to our projections, their aggregate gross income rivaled that of the elite, corresponding to anywhere from half to one-and-a-half times of the latter's (Table 11).[92] Their disposable income – gross income minus gross subsistence – would have been smaller but still amounted to between 10 and 20 percent of total GDP or between half and more than once non-subsistence elite income, or between two and four times public sector income. Only when we focus on disposable income above 'respectable' consumption levels, set at 2.4 times minimum gross subsistence, does elite income exceed 'middling' income by a palpable margin. In the most general terms, a bit over half of all income was necessary to cover minimum gross subsistence; maybe 15 percent covered the range between 'bare bones' subsistence and 'respectable' consumption levels; and 30 percent exceeded the latter.

[91] For this basic point, see already above, p.5.
[92] All calculations derived from Tables 8, 9, and 10.

Table 11 Income shares according to different scenarios of income distribution (in percent)

	'Pessimistic'	'Optimistic'
Total gross income		
Elite	26	17
Middling	16	27
Other	58	56
Gross income beyond gross subsistence		
Elite	57	38
Middling	28	47
Other	15	16
Gross income between gross subsistence and 2.4 times gross subsistence		
Elite	11	6
Middling	40	52
Other	49	42
Gross income above 2.4 times gross subsistence		
Elite	76	56
Middling	24	44
Other	-	-

For the first time, this – necessarily very approximate – breakdown sheds some light on the fundamental segmentation of the Roman consumer market.[93] Income that facilitated consumption between 'bare bones' subsistence and 'respectable' consumption levels was earned by 'middling' groups and poorer households in equal measure. We may conjecture that this income sustained mostly local production and exchange. This was the main market for non-essential goods that are not consumed proportionate to income.[94] Some of these goods would have been locally available, most notably meat; others may have been traded, such as wine, oil, metal items, and glassware; or both in other cases, such as textiles. A numerically small elite necessarily consumed fewer of these goods than a far less affluent but much larger segment of 'middling' households and those who were just a bit above subsistence. Moreover, our figures show that non-elite demand for such goods must have dwarfed demand by the Roman military sector. For these reasons, our model is of relevance to any analysis of remains of economic activity involving such items.

[93] Since most, though by no means all, households would have met their subsistence needs through food production at the household level, a large proportion of subsistence demand was removed from the market and is not considered here.

[94] These are goods which some people were too poor to consume at all while the rich would only consume a finite amount of them rather than an amount that was directly proportionate to their income. Meat is a good example: see Jongman, 'Consumption' (n.1), 613 for the point that while the very poor may not have eaten any meat and the somewhat better off would have consumed certain amounts, the super-rich could not have ingested vast quantities.

By contrast, income beyond a level that ensured 'respectable' consumption was unavailable to the overwhelming majority of households. In this sector of demand, 'middling' groups continued to play a significant role by accounting for between one-quarter and one-half of the required aggregate surplus. We may conjecture that at that level of consumption, goods that were traded over greater distances enjoyed greater prominence. This casts doubt on reductive models that identify elite (and public sector) demand as the critical driving force behind interregional exchange.[95] Our model of income distribution is consistent with a measure of division of labor and trade sustained by non-elite markets, at least for goods that were less extravagant than those that underpinned elite identity through conspicuous consumption.

'Middling' households, and thus disposable non-elite income, need not have been evenly spread out across the empire. The greater their spatial concentration, the larger their economic impact and social standing would have been. The 'consumer-city' regime of the Roman world encourages speculation that civilian 'middling'-income groups may have been disproportionately present in urban contexts, even if this idea ultimately defies empirical verification.[96] For instance, if some 15 percent of the total population resided in towns and 'middling' income households were twice as common there as in the countryside, anywhere from one-eighth to one-quarter of the urban populace might have fallen in this 'middling' category.[97] However, a substantially higher degree of concentration would imply that rural areas were almost entirely populated by subsistence-level households, which seems unrealistic. This in turn imposes a ceiling on optimistic notions of urban living standards. In any case, subsistence-level households must have formed a solid majority even in urban settings. (Regional variation in income levels may well have been considerable but must await more detailed discussion in a future sequel to the present study.[98])

More generally, our reconstruction is fundamentally at odds with overly schematic 'binary' visions of a Roman society divided into 'rich' and 'poor'.[99] At the same time, it puts more recent expressions of optimism about Roman economic performance into perspective by highlighting the probable constraints on non-elite disposable income and living standards.[100] Reduced to essentials, our argument is very simple. If the Roman Empire supported several hundred thousand elite households (as discussed in Section III), there ought to have been an even larger number of households with smaller incomes that nonetheless exceeded subsistence levels by a significant margin. However, given a variety of constraints on our estimates of the overall size of the Roman economy (discussed in Section II), in any internally consistent model such households could only dispose of resources on a scale that neither depressed elite consumption below plausible levels nor left insufficient room for basic subsistence-level spending by the large majority of the population. In other words, given what we are told about elite incomes, the presence of a much larger or wealthier 'middling' segment would have required a much larger GDP and hence mean per capita income levels that would imply higher levels of overall economic development than the Roman world can be shown to have attained.[101]

Therefore, 'middling' incomes must necessarily have remained the exception while subsistence was the norm, and high inequality skewed the distribution of any gains from

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[95] See, e.g., C. Wickham, *Framing the Early Middle Ages* (2005) *passim* for the supposed dominance of elite and state demand.

[96] The best exposition of the 'consumer-city' concept is P. Erdkamp, 'Beyond the limits of the 'consumer city': a model of the urban and rural economy in the Roman world', *Historia* 50 (2001), 332-56. Urban residence did not preclude non-urban sources of income.

[97] Cf. the hypothetical income scale for large cities in Friesen (n.3), 337-47.

[98] See above, n.50, and cf. Scheidel (n.3), 50-1 for an earlier sketch.

[99] See above, n.4.

[100] See the work by de Callataÿ, Hitchner and Jongman cited above in n.1.

[101] It is worth re-iterating that for this reason, our reconstruction does not rest on circular reasoning beyond very basic comparativist contextualization: see above, in the first part of Section II.

development. Nevertheless, our estimates suggest that 'middling' incomes could hardly have failed to complement elite spending power to a very significant degree. Physical evidence of Roman prosperity in the form of infrastructure and traded goods will therefore best be understood as the most visible manifestation of demand generated by the most affluent tenth of society. More specifically, artifacts such as the putatively 'small farms' that may be discerned in the archaeological record (and were thus most likely sufficiently substantial to reflect economic activity beyond basic subsistence farming) or inscriptions and papyri that record ownership of one or two slaves are most likely to derive from the more robust elements of the 'middling'-income tier. Yet the disproportionate visibility of this 'fortunate decile' must not let us forget the vast but – to us – inconspicuous majority that failed even to begin to share in the moderate amount of economic growth associated with large-scale formation in the ancient Mediterranean and its hinterlands.[102]

[102] For an analysis of the nature of Roman economic growth and its built-in constraints, see now Scheidel forthcoming (n.1).